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(54) Wellhead assembly

(57) The present invention provides a wellhead assembly which mitigates the disadvantages incurred by the non-interchangeable nature of single stack and two stack wellhead systems. The invention provides a wellhead assembly including one or more conversion sleeves (42, 52) which enable the assembly to be installed and operated using either a single stack rig or a two stack rig. Preferably, the primary conversion sleeve (42) is located between two casing hangers (26, 44) and is configured to receive a tubing hanger (54).

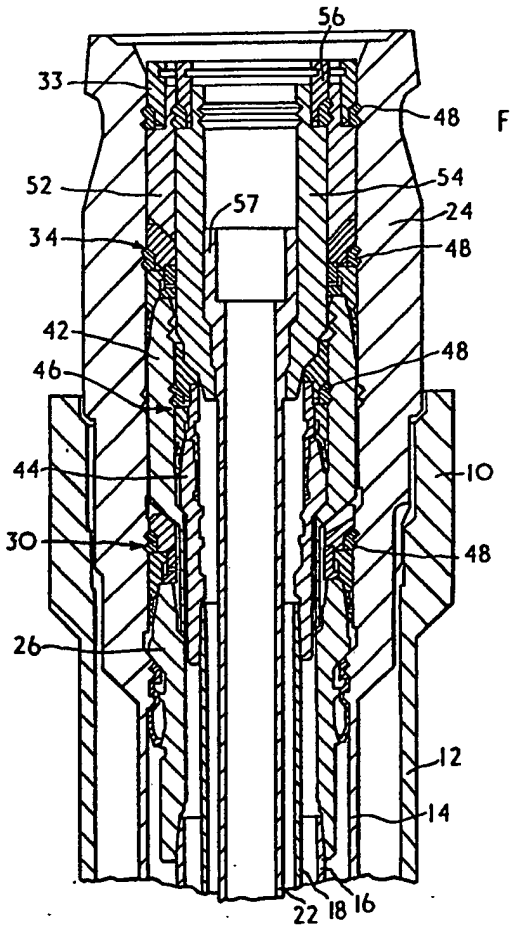

FIG.3.

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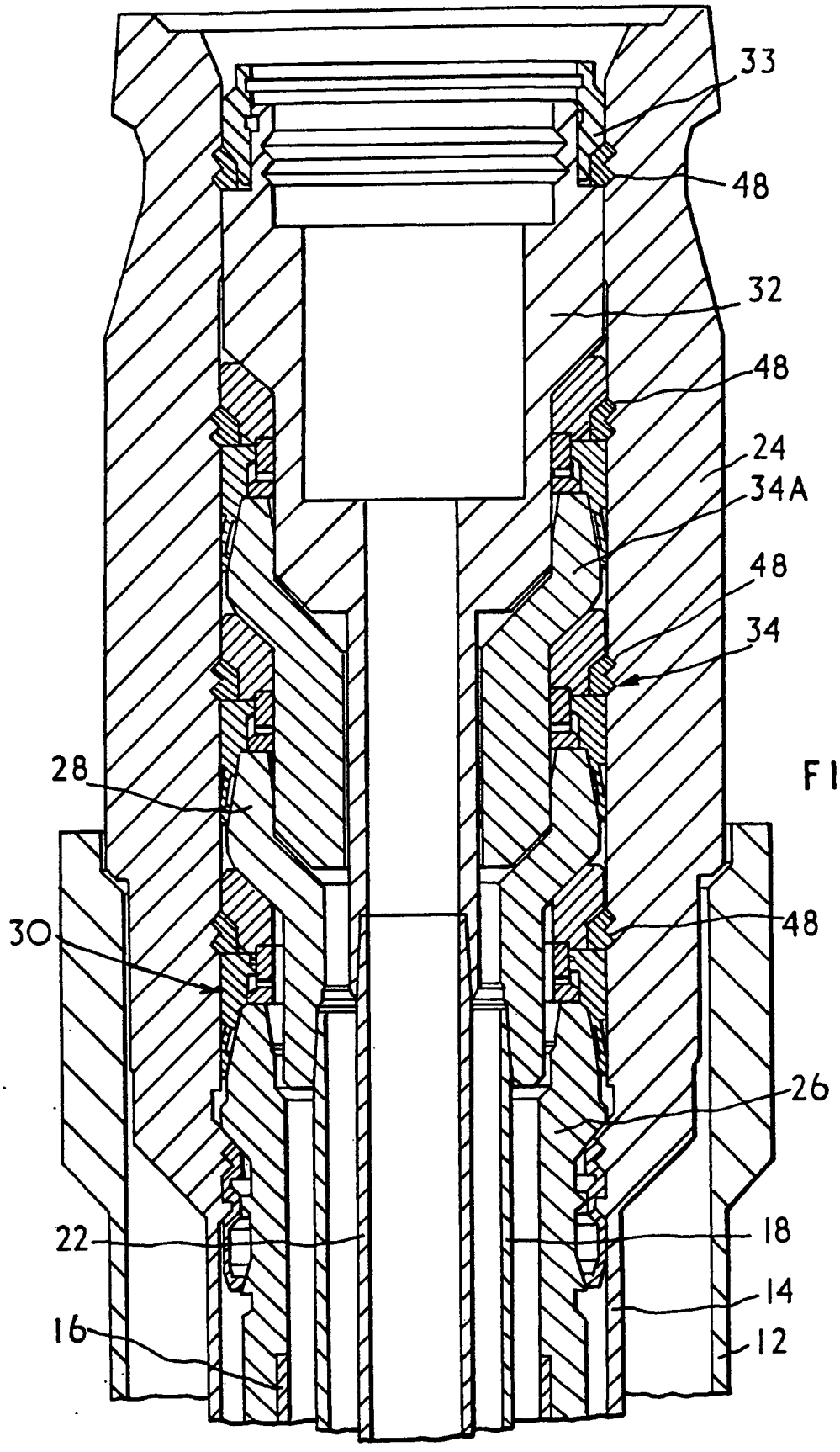

FIG. 1

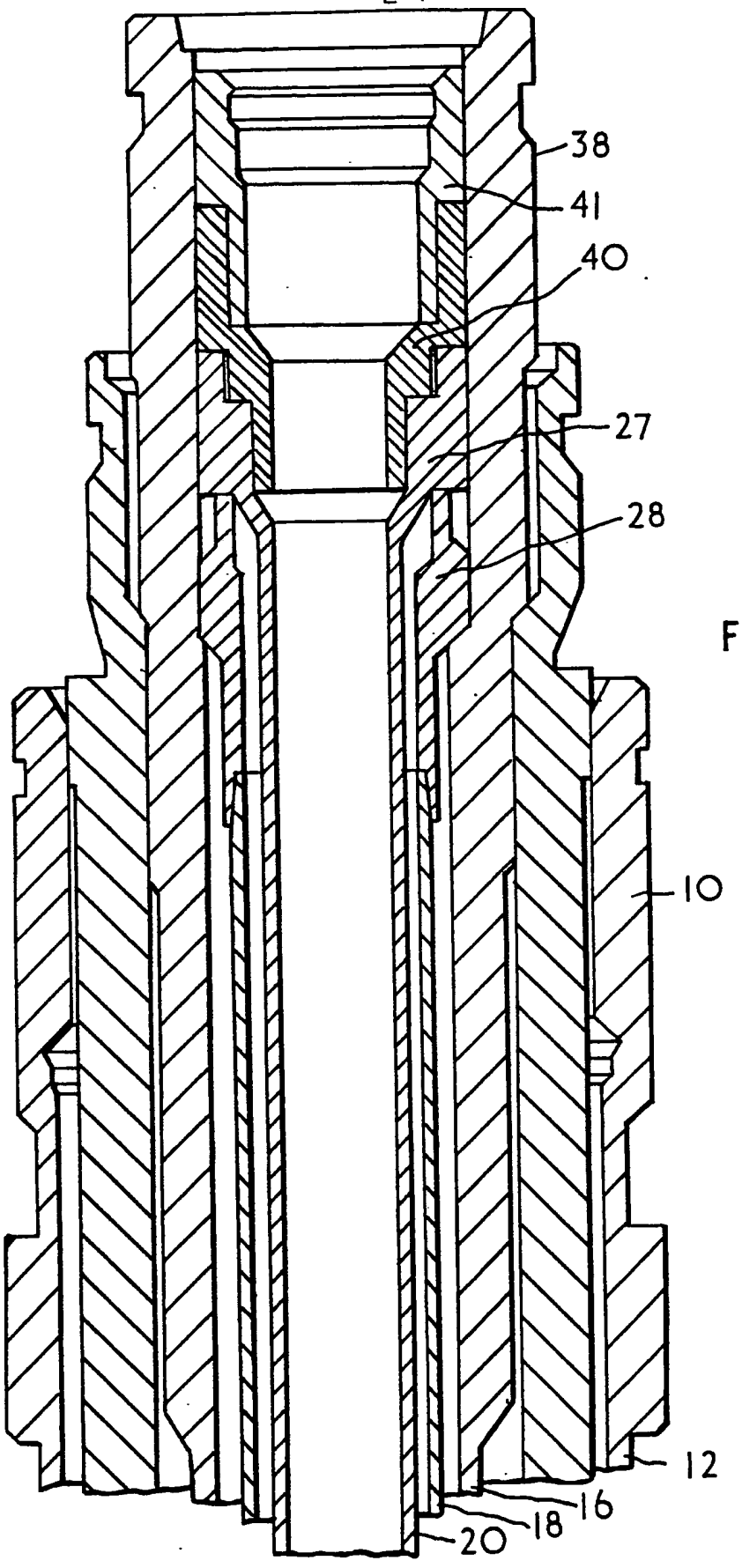

FIG. 2.

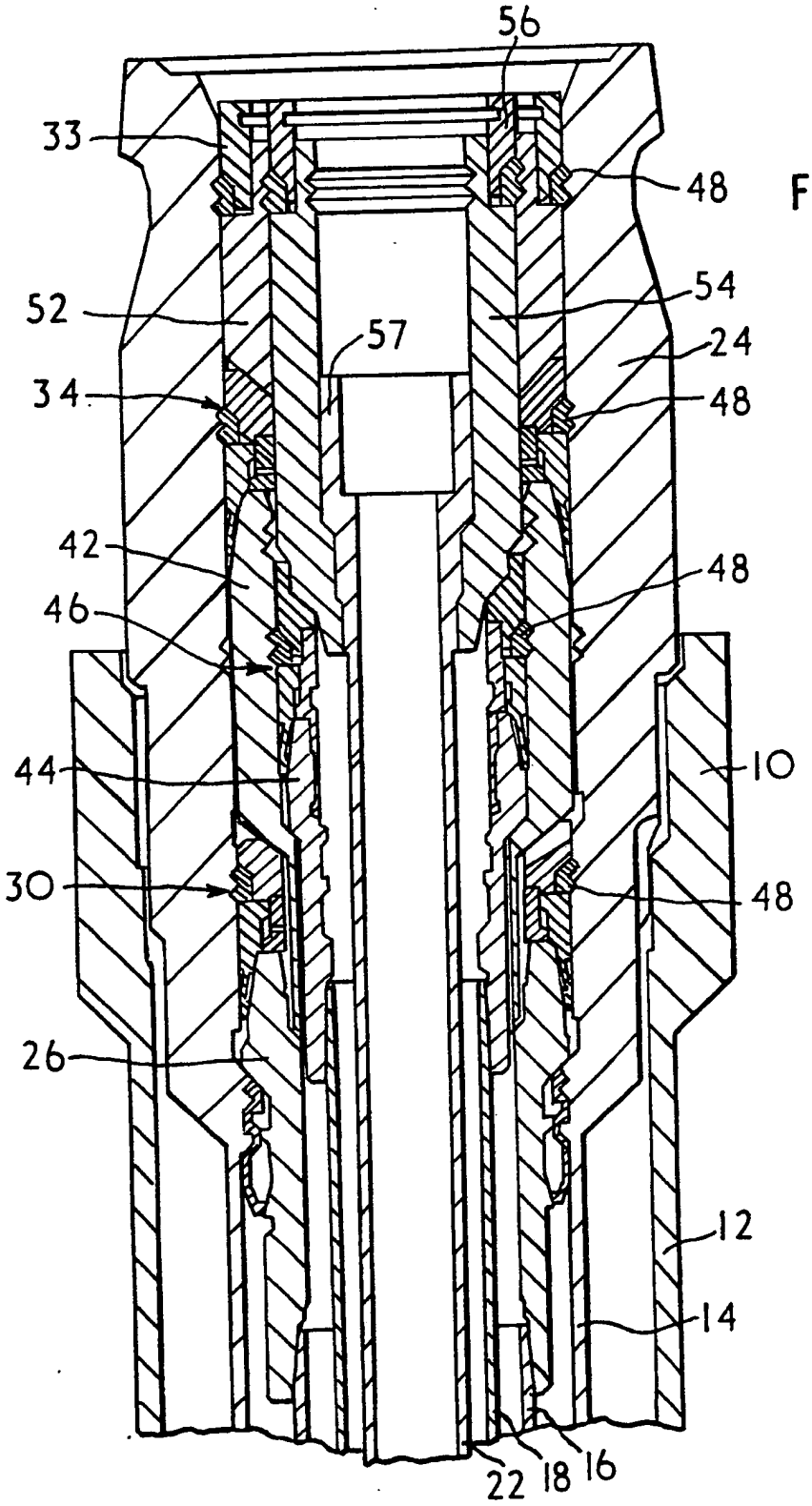

FIG.3.

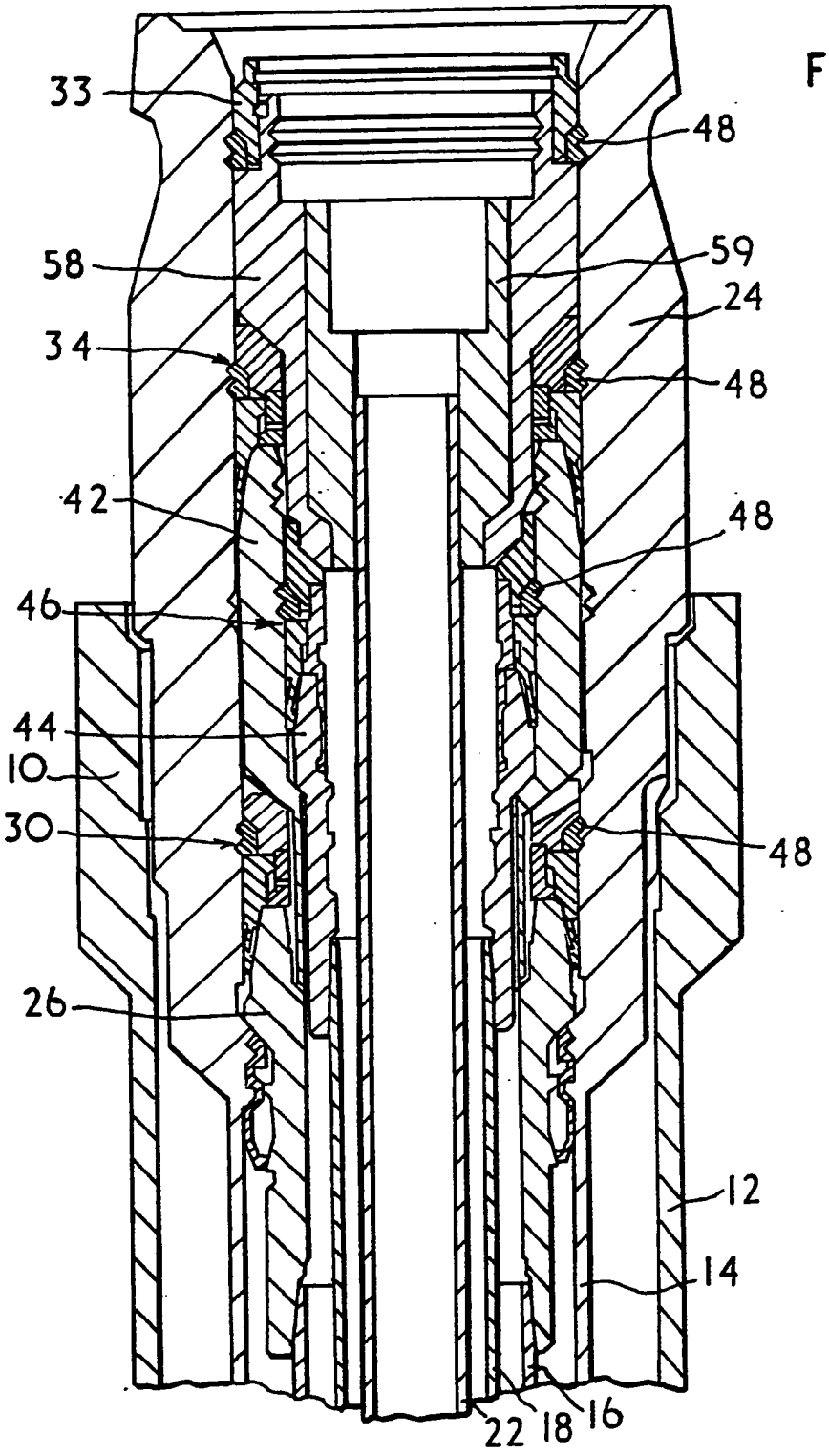

FIG.4.

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Wellhead Assembly

The present invention relates to a wellhead assembly for a fluid production system such as an oilwell.

In drilling and completing an oilwell, it is well known to use wellhead equipment. This comprises, in the main, a wellhead body, casing hanger(s), annulus packoff(s), and a tubing hanger. The wellhead body and the casing hanger(s) form the upper termination of the various concentric casings which, in their turn, define the well bore itself. Both the wellhead body and the casing hanger(s) are component pressure vessels in the construction of the well.

A wellhead body is distinguished by two features. First, it is prepared to accept attachment of a well fluid control device. During drilling and completion, this is a blowout preventer (BOP); during production this is a Christmas tree. Second, it is prepared to accept during drilling the installation in its bore of one or more casing hangers and their associated annulus packoffs, as well as a tubing hanger.

Annulus packoffs bridge and seal the annulus between

concentric well pressure vessels, assuring continuity and integrity of the wellbore as a single pressure vessel.

The tubing hanger is, in essence, a specialized casing hanger, ordinarily provided with an integral packoff mechanism.

Because a wellhead body is sized to accommodate attachment of blowout preventers, and because the hangers and packoffs installed in the wellhead must pass through the BOP's on installation, the sealing bore size of the wellhead is always related to the bore size of the BOP. Specifically, the wellhead sealing bore is always smaller, if only slightly smaller, than the BOP bore.

Because the wellhead body forms part of a unified well pressure vessel with the BOP attached to it, its pressure capacity must be greater than or equal to the pressure capacity of the associated BOP. Historically, large bore BOP's have had lower pressure ratings and small bore BOP's have had higher pressure ratings. The same has thus held true of large bore and small bore wellheads. This trend is related to strength of materials analysis of pressure induced hoop stress.

As the depth of a well into the arth increases, pressures encounted also increase. As the depth increases, increasingly small casings are utilized to define the wellbore. These smaller, higher pressure capacity casings can be accommodated in smaller, higher pressure wellheads, controlled by smaller, higher pressure BOP's.

Historically, wellheads for use on land (and on platforms) evolved to use multiple wellheads on a single well, sequentially smaller in bore and higher in pressure rating. These were mated with sequentially smaller, higher pressure BOP's. Consequently, casing hangers and annulus packoffs became sequentially smaller as drilling of the well progressed.

For drilling offshore, subsea wellheads were developed as an evolutionary step from surface wellheads. As a consequence, this multiple wellhead, multiple stack approach was also adopted. Given the peculiar difficulties of drilling wells offshore from floating facilities, subsea wellheads were originally standardised using just two BOP stacks.

Use of two BOP stacks, one large bore and low pressure, the other small bore and high pressure, worked a certain disadvantage on the progress of subsea wellhead use.

The added equipment required limited the capabilities of rigs, especially for deep water. Drilling procedures were complex and time consuming. Even so, many floating drilling rigs were outfitted this way.

Development of large bore, high pressure BOP's eventually allowed subsea wellhead to adopt a single stack approach to drilling. This utilized one large bore, high pressure stack with one large bore, high pressure wellhead. Equipment and procedures were streamlined. Many floating drilling rigs were outfitted this way.

Thus, two conventional subsea wellhead systems are now in use, the two stack and single stack systems. The two stack system typically comprises a 21 1/4" nominal wellhead body and a 13 5/8" nominal wellhead body landed therein. The single stack system typically comprises an 18 3/4" nominal wellhead body.

Because a floating drilling rig is characterized by its BOP system, and because a wellhead system is characterized by its associated BOP system, a problem thus arises. A rig suitable for drilling with single stack wellhead is not suitable for drilling with two stack wellhead, and vice versa. This can cause considerable problems in practice. For example, an

organisation's full complement of rigs of one type may be heavily committed whereas rigs of the other type may be under-utilised, at one particular time.

A second problem arises in workovers, especially tubing pulling workovers, of completed, producing subsea wells. In a typical workover, the well flow is stopped downhole and the Christmas tree is removed. Then a BOP stack is reinstalled on the wellhead to establish safe well control, and the tubing hanger, tubing, and some or all downhole completion equipment is removed, renewed, and reinstalled. Because the procedure requires installation of a full bore BOP stack, the incompatibility of single stack and two stack systems again stands as an impediment to optimum rig utilization.

It is noted in this same connection that, for a variety of reasons, operators may prefer to use a small bore BOP for workovers. The advantage here lies principally in the smaller size and weight of the BOP stack.

Alternatively, an operator may find it advantageous to be able to use a large O.D. tubing hanger (from a single stack system) in a well originally drilled with the two stack system. The advantage here lies both in flexible use of inventory and in certain intrinsic advantages in the features of a larger tubing hanger.

With a view to mitigating the above disadvantage, the present invention provides a wellhead assembly including one or more conversion sleeves which enables the assembly to be installed and operated using either a single stack rig or a two stack rig.

An embodiment of the invention will now be described by way of example only and with reference to the accompanying drawings, in which:

Figure 1 illustrates a conventional single stack wellhead assembly;

Figure 2 illustrates a conventional two stack wellhead assembly;

Figure 3 illustrates an embodiment of the present invention arranged to implement a two stack wellhead assembly; and

Figure 4 illustrates the embodiment shown in Figure 3 but arranged to accept the tubing hanger from the single stack wellhead assembly.

Throughout the drawings the same reference numerals are used to denote common components.

Each of the illustrated wellhead assemblies is based upon a 30" suspension joint denoted by reference numeral 10. Directly depending from suspension joint 10 is a 30" casing 12. By various components, described below, suspension joint 10 gives support to: a 20" casing 14, a 13 3/8" casing 16, a 9 5/8" casing 18 and in some instances a 7" casing 20 (Figure 2) or a 5 1/2" tubing 22 (Figures 1, 3 and 4).

In the conventional single stack wellhead assembly, as shown in Figure 1, the 20" casing 14 is supported by a 18 3/4" wellhead 24. The wellhead 24 is landed in the 30" suspension joint 10. A 13 3/8" casing hanger 26 is landed in wellhead 24. A pack-off assembly, generally designated 30, is installed on the 13 3/8" casing hanger. It then supports, in turn, a 9 5/8" casing hanger 28. A second pack-off assembly 34 is installed on the 9 5/8" casing hanger. A 5 1/2" tubing hanger 32 is supported on the second pack-off assembly 34, via the spacer bushing 34A. The bushing elevates the tubing hanger to the appropriate height. Tubing hanger 32 provides a cylindrical inner profile which receives the stinger when a wellhead connector, along with the associated Christmas tree, is lowered over wellhead 24 and latched to the outer configuration thereof. It is noted that all of the components installed within wellhead body 24 are of such an outside diameter as to

requir an 18 3/4" BOP to allow them to pass through the BOP for installation.

The conventional two stack wellhead assembly is shown in Figure 2. The arrangement of the 30" suspension joint 10 and the various casings depending from the wellhead are basically the same as for the single stack wellhead assembly. The 20" casing 14 is supported by a 20" casing hanger 36 which has an external configuration comparable to that of the 18 3/4" wellhead 24 of the single stack assembly. Indeed, casing hanger 36 amounts to the first of the two wellheads from which this assembly derives its name. A 13 5/8" wellhead body 38 is landed within casing hanger 36 and wellhead body 38 constitutes the main wellhead of the assembly. That is, the stinger carrying wellhead connector, along with the associated Christmas tree, latches onto the external configuration of wellhead body 38. The external configuration of casing hanger 36 plays no part in the retention of that wellhead connector.

Supported within wellhead body 38 is a 9 5/8" casing hanger 28 and pack-off 27 which are functionally equivalent to that of the single stack assembly. A 7" tubing 20 is supported by a tubing hanger 40 and pack-off 41, landed upon casing hanger and pack-off 28.

It is noted that the wellhead body 38 is of such an outside diameter as to require a 21 1/4" BOP to allow it to pass through the BOP for installation. Furthermore, all of the components installed within wellhead body 38 are of such an outside diameter as to require only a 13 5/8" BOP to allow them to pass through the BOP for installation.

An embodiment of the present invention is shown in Figures 3 and 4 of the drawings. In Figure 3 the assembly is configured as a substitute for a conventional two stack arrangement, but utilising the same main wellhead body as in the single stack arrangement in Figure 1. In Figure 4 the assembly is similarly configured as a substitute for a conventional two stack arrangement, but in addition utilising the tubing hanger from the single stack arrangement in Figure 1. In the illustrated embodiment of the present invention, a conventional 18 3/4" wellhead body 24 is supported by the 30" suspension joint 10. Landed within the wellhead body 24 is a conventional 13 3/8" casing hanger 26. A pack-off assembly, generally designated 30, is installed on the 13 3/8" casing hanger. It then supports, in turn, a special long conversion sleeve 42. A second pack-off assembly 34 is installed on the special long conversion sleeve. The long conversion sleeve 42 supports an adapted 9 5/8" casing hanger 44.

A specially configured pack-off assembly 46 is installed on casing hanger 44 and is latched to sl eve 42.

When it is desired to use the wellhead assembly as a substitute for a conventional two stack assembly, a special short conversion sleeve 52 is used together with a concentric tubing hanger 54. Refer to Figure 3. The short conversion sleeve 52 is supported by pack-off assembly 34 and latched into wellhead body 24 by the conventional retaining means 33 and 48. Concentric tubing hanger 54 seats on the special pack-off assembly 46 and is latched to the internal surface of sleeve 52 by a further retaining means 56. A 5 1/2" tubing suspension mandrel 57 is a component of, and is landed with, concentric tubing hanger 54, as illustrated.

It is noted that all of the components installed within the two conversion sleeves 42 and 52 are of such an outside diameter as to require only a 13 5/8" BOP to allow them to pass through the BOP for installation. Furthermore, it is noted that the remaining components installed within wellhead body 24 are of such an outside diameter as to require either an 18 3/4" or 21 1/4" BOP to allow them to pass through the BOP for installation.

When it is desired to use the wellhead assembly first as a substitute for a conventional two stack assembly

during drilling, but then as a substitute for a conventional single stack assembly during completion, a concentric tubing hanger 58, 59 is landed within wellhead body 24 and supported by the pack-off assembly 34, as illustrated in Figure 4. This replaces the special short conversion sleeve 52. As illustrated, the concentric tubing hanger 58, 59 supports a 5 1/2" tubing 22 although a 7" casing hanger and casing could be used if desired. The concentric tubing hanger 58, 59 is latched into the wellhead body 24 by a conventional retaining means 33. It will be appreciated that the final configuration of the wellhead assembly as interacts with the wellhead connector and stinger is the same in both Figures 1 and 4.

It will also be appreciated that in both the single stack and the two stack modes, the embodiment of the invention is completed using an 18 3/4" wellhead connector. In the single stack arrangement, the connector will be carried on an 18 3/4" Blow Out Preventer Stack. In the two stack arrangement, the connector will be carried on a 21 1/4" and then on a 13 5/8" Blow Out Preventer Stack. In both arrangements, the connector will be carried on the Christmas tree, although the stinger may be different.

It can thus be seen that the present invention permits

the drilling and completion of a fluid production system, viz an oilwell, using either the single stack or the two stack approach. Minimum variation is required in the equipment used and in its configuration. Furthermore, the system, once completed, can be reentered for workover using either the single stack approach or the two stack approach, even if it was originally drilled and completed using the two stack approach. Hence, the single stack or two stack approach can be selected in accordance with rig availability, maximizing efficiency or rig utilisation.

Claims:-

1. A wellhead assembly including one or more conversion sleeves which enables the assembly to be installed and operated using either a single stack rig or a two stack rig.

2. A wellhead assembly as claimed in claim 1 and comprising a wellhead body, a suspension joint and two casing hangers wherein a first conversion sleeve is landed on the outermost of the two casing hangers and the innermost of the two casing hangers is landed on the conversion sleeve.

3. A wellhead assembly as claimed in claim 2, wherein the conversion sleeve is configured to receive a concentric tubing hanger.

4. A wellhead assembly as claimed in claim 2 or 3, further comprising a second conversion sleeve retained in the upper portion of the wellhead body to reduce the bore thereof to receive a tubing hanger.

5. A wellhead assembly as claimed in any of claims 2 to 4, wherein the tubing hanger is received on a pack off assembly, the pack off assembly being retained by the first conversion sleeve and having a component which extends within the innermost casing hanger.

6. A wellhead assembly as claimed in claim any of claims 2 to 5, wherein the wellhead body is a 18 3/4 inch wellhead body.

7. A wellhead assembly as claimed in any of claims 2 to 6, wherein the outermost casing hanger is a 13 3/8 inch casing hanger.

8. A wellhead assembly as claimed in any of claims 2 to 7, wherein the innermost casing hanger is a 9 5/8 inch casing hanger.

9. A wellhead assembly as claimed in any preceding claim, wherein the assembly is arranged for use with a connector carried on a 18 3/4 inch blow out preventor.

10. A wellhead assembly as claimed in any of claims 1 to 8, wherein the assembly is arranged for use with a connector carried on a 21 1/4 inch blow out preventer and for subsequent use with a connector carried on a 13 5/8 inch blow out preventor.

11. A wellhead assembly substantially as herein before described with reference to and as illustrated in Figures 3 and 4 of the accompanying drawings.

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